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BIOLOGY OF THE COMMERCIAL FISHES OF THE GULF OF MEXICO

By GEORGE A. ROUNSEFELL, *Fish and Wildlife Service, United States Department of the Interior*

The ecology of the fishes of the Gulf of Mexico differs in many respects from that of the Atlantic coast. The offshore waters of the Gulf (as indicated by current investigations by the Fish and Wildlife Service) are low in nutrients; the largest fish populations are thus found in the littoral zones where the nutrients necessary to grow the organisms forming the base of the food chain are washed from the land by rains and floods and carried in by rivers (Riley 1937).

At 1,200 fathoms the water masses in the Caribbean Sea are warmer and less dense than those outside the perimeter of the Caribbean. Those latter cold-water masses are derived from water that has sunk in high latitudes (Parr 1937, 1938). It therefore intermittently runs over the sills between the islands of the Antilles and flows down into the Caribbean and Cayman Basins. An intermediate water mass above 1,000 fathoms moves westward through the Caribbean between depths of 245 and 500 fathoms. This water, of Antarctic origin, is rich in nutrients. Between 100 and 250 fathoms the entering water is chiefly of South and North Atlantic central water origin.

There is little surface upwelling in the Caribbean, but on the Venezuelan coast the tilt of the water layers brings nutrient-rich waters up to the euphotic zone. The Gulf of Mexico derives its deep waters from water flowing from the Caribbean Sea over the sill in the Yucatán Channel which is not so deep as the main entrances to the Caribbean Sea. Proximity to this inflowing current may account for the productivity of the fisheries of the Campeche Banks.

Most of the new water entering the Gulf apparently flows out again through the Straits of Florida so that the main part of the Gulf is more or less of a cul-de-sac. This may influence the low nutrient content of the offshore waters of the Gulf.

As in most subtropical waters the high temperatures cause rapid growth. The same or related species in the Gulf tend to grow faster than on the northern Atlantic coast; they attain maturity at younger ages and are usually smaller in size. The life histories of many of the fishes of the Gulf are practically unknown. Some of those that occur both in the Gulf and along the Atlantic coast have been studied on the Atlantic coast, and presumably their life histories in Gulf waters are similar. Within the Gulf proper, mention should be made of the studies by Pearson, Gunter, and Gowanloch. However, the area is so vast, the species so numerous, and the conditions so diverse that the total knowledge is meager when compared to that of the Pacific or Atlantic coasts.

It is known that certain species can be caught in certain localities, but no detailed study is available on many of the most abundant species such as the menhaden, the anchovy, the Spanish mackerel, the groupers, and the snappers. Ginsburg (1930), in describing the biology of the common red snapper, *Lutianus aya*, says, "the red snapper is one of the important food fishes of this country. . . . Among the commercial food fish of the Gulf coast . . . the red snapper is second in point of quantity obtained, being exceeded only by the mullet . . . it is significant that practically nothing is known regarding the life history of the red snapper."

The relative abundance of the different species of fish is not accurately known, especially for those not landed by fishermen or only taken incidentally while in pursuit of other species. In estimating relative abundance, Gunter (1945a) uses the term "total species mass." He states that, "The estimates of relative species mass of the fishes given here are based on general impressions and observations, bolstered to some extent by data, and are admittedly more subjective than is desirable. It is quite certain, however, that irrespective of their rank in species mass, the species discussed are the most numerous fishes in Texas coastal waters." For the inshore fishes

of the northern and western Gulf, Gunter ranks the species as follows:

1. Anchovy, *Anchoa mitchilli diaphana.*
2. Mullet, *Mugil cephalus.*
   Menhaden, *Brevoortia* sp.
   Croaker, *Micropogon undulatus.*
3. Silverside, *Menidia beryllina peninsulae.*
   Sheepshead minnow, *Cyprinodon variegatus variegatus.*
4. Catfish, *Galeichthys felis.*
   Sandtrout, *Cynoscion arenarius.*
5. Red drum, *Sciaenops ocellata.*
   Speckled trout, *Cynoscion nebulosus.*
   Black drum, *Pogonias cromis.*

It will be noted that the species at the top of the list are preponderantly plankton feeders. They must form one of the chief layers in the food chain, linking the macroplankton to the predaceous fishes.

The food fishes in the Gulf I have grouped according to their habitat into at least five categories that seem to fit reasonably well with the known facts:

1. The bank fishes that are taken chiefly on the offshore banks. The best known is the red snapper, *Lutianus aya*, taken throughout the Gulf on numerous banks including the Campeche Bank.

2. Stenothermal species that are not found in abundance around the northern perimeter of the Gulf. This applies to many species in the Florida Keys such as the grunts (*Haemulon* spp.).

3. Inshore species whose abundance, because of their life history, is largely dependent on the ecological conditions in the inner bays and shallows. Examples are the red drum, *Sciaenops ocellata*, the croaker, *Micropogon undulatus*, and the mullet, *Mugil cephalus.*

4. Offshore species whose life histories make them more or less independent of the waters between the mainland and the barrier islands. These include the menhaden, *Brevoortia*, the pompano, *Trachinotus carolinus*, the butterfish, *Poronotus triacanthus*, and the Spanish mackerel, *Scomberomorus maculatus.*

5. Anadromous and estuarine species that either go into fresh water at certain times or live in fresh or brackish waters. Examples are the gizzard shad, *Dorosoma cepedianum*, the striped bass, *Roccus saxatilis*, the sea catfish, *Galeichthys elis*, and the snooks, (*Centropomus* spp.).

The offshore bank fishery has been described by Jarvis (1935). There are in reality two fisheries: one by small boats that fish along the shores of the Gulf, especially along the west coast of Florida and among the Florida Keys, the other by large vessels sailing from Pensacola and a few minor ports. These larger vessels also fish the shores of the Gulf out to the 100-fathom curve (but not close inshore). However, they take the bulk of their catch from the numerous offshore shoals lying north and west of Yucatán and known collectively as Campeche Bank.

In the waters fished by the offshore vessels (about 15 to 100 fathoms) the catch consists largely of groupers and snappers, the latter preferring the deeper water. Of the snappers the most abundant is the common red snapper, *Lutianus aya.* The silk or yellow-eye snapper, *Lutianus vivanus*, is caught in deeper water than the red snapper. The Caribbean red snapper, *Lutianus aya* (regarded by Ginsburg 1930, as a separate species), is fairly abundant on the eastern part of the Campeche Bank. The black-fin snapper, *Lutianus buccanella*, abundant in the Caribbean, is taken in small quantities from the deeper waters of Campeche Bank. The smaller vessels, when fishing in the shallower waters along the Florida coast and amongst the Florida Keys, take several other snappers, especially the gray or mangrove snapper, *Lutianus griseus*, the schoolmaster, *L. apodus*, the muttonfish, *L. analis*, the Lane snapper, *L. synagris*, and the yellowtail, *Ocyurus chrysurus.*

The offshore vessels also make large catches of groupers consisting principally of the red grouper, *Epinephelus morio.* Among the Florida Keys there are several groupers usually taken: the yellowfin grouper, *Mycteroperca venenosus*, the black grouper, *M. bonaci*, the gag, *M. microlepis*, the scamp, *M. falcata*, and the jewfish, *Promicrops itaiara.*

The fisheries in the vicinity of Key West are described by Schroeder (1924). The most striking feature is the large number of species taken among the Florida Keys and along the southern tip of Florida that are either absent or scarce in the northern Gulf.

The western and northern shores of the Gulf are fringed by narrow barrier islands and reefs that cut off long, shallow bays parallel to the

coast. Only a few narrow passes connect these inner bays with the open Gulf. Because of the low range of tide levels this results in weak circulation of water between the bays and the Gulf. As a result, these bays exhibit wide ranges in temperature and salinity. The rise in the rivers following the winter rains causes a great drop in salinity; many of the bays are almost fresh for periods of a few months. Many of them normally have a salinity around 15 to 20 parts per thousand contrasted with nearly 35 parts in open ocean water. During the winter a strong, cold, north wind occasionally drops the temperature very suddenly and many of the cold-sensitive fish are killed before they can reach deep water.

The importance of the passes connecting the bays to the open Gulf is shown by the life histories of many of the species. Thus, the redfish or red drum, *Sciaenops ocellata*, the croaker, *Micropogon undulatus*, the black drum, *Pogonias cromis*, the spot, *Leiostomus xanthurus*, and the striped mullet, *Mugil cephalus*, all important sport and commercial species, crowd through these narrow passes during the fall and early winter to reach the open Gulf. Here they spawn, chiefly in the vicinity of the passes. The post-larval and young of these species are later observed in vast schools entering the passes from which they spread throughout the shallow, inner bays. A few species, such as the spotted sea trout, speckled trout, or squeteague, *Cynoscion nebulosus*, spawn within the inner bays.

One of the most interesting areas biologically is the Laguna Madre, a narrow bay 115 miles long, paralleling the Texas coast. No rivers enter the Laguna, and its only present connection with the Gulf is through Corpus Christi Bay at the northern end. In depth it ranges from a few inches to 4 feet, with occasional deep holes. As a result of the shallow depths, the lack of permanent stream drainage, the high evaporation rate, and the poor connection with the Gulf, the monthly average salinity of the upper Laguna is above 50°/₀₀, and in some years salinities well over 100°/₀₀ are found.

Despite these conditions it produces a large quantity of fish. When the salinity rises above a critical point (about 72°/₀₀, Gunter 1945b) fish start dying by the thousands. This happens every few years. Because of the life histories of the species involved and the absolute necessity that the young find suitable conditions in the inside bays, perhaps the chief fishery problem of the region is the maintenance of proper conditions in these bays.

Because of the lack of any major streams the important feature in the Laguna Madre is the high salinity. The shallowness of the water makes it impossible to obtain any significant circulation through a narrow pass, no matter what its depth, so that the only major changes in salinity occur when there is a rise in the water level across the wide, northern entrance to Corpus Christi Bay. As the tide ranges are slight the extra high levels occasionally attained through the piling up of water by strong, inshore winds are of major importance to the circulation in the Laguna.

Excluding the Laguna Madre, most of the bays behind the barrier islands and reefs are entered by large rivers. The problem in these bays is, in part, similar to that of the Laguna. They differ, however, in that while high salinity is the problem in the Laguna, these other bays are troubled chiefly by low salinity. The difficulty has heightened with the passing years as soil erosion and sparse vegetative ground cover caused by overgrazing has intensified the magnitude of the floods. The problem in these other bays may be solved eventually through better agricultural practices and through flood control and power dams that will assure a steadier flow of fresh water. A certain amount of fresh water is needed to prevent conditions similar to those in the Laguna, but too much fresh water in a short period drops the salinity to almost zero. Because of the poor circulation these flood waters take many weeks to become mixed with water from the Gulf.

In addition to those species that depend on the ecological conditions in the inner bays, there are many species on the perimeter of the Gulf whose life histories, so far as known at present, render them more or less independent of conditions in the inner bays. These probably include the menhaden, *Brevoortia*, the pompano, *Trachinotus carolinus*, the butterfish, *Poronotus triacanthus*, and the Spanish mackerel, *Scomberomorus maculatus*. The actual degree to which any one species is dependent on the inside waters is at present largely a matter of speculation. The answer lies in continued research.

There are also many species of estuarine and anadromous fishes in the Gulf. Gunter (1945a)

TABLE 1.—*United States fish production in the Gulf of Mexico and eastern Florida in 1945*

[In thousands of pounds; based on Anderson and Power, 1950]

Species	Texas	Louisiana	Mississippi	Alabama	Florida	Total
Bank species (chiefly offshore):						
Red snappers, *Lutjanus* sp	288	26	12	1,361	3,092	4,779
Groupers	17	3	7	169	8,593	8,789
Bank and reef species (except offshore):						
Mangrove (gray) snapper, *Lutianus griseus*					214	214
Jewfish, *Promicrops itaiara*	12	2		3	423	440
Muttonfish, *Lutianus analis*					213	213
Yellowtail, *Ocyurus chrysurus*					330	330
Sea bass, *Centropristes* sp					101	101
Grunts, *Haemulon* sp					188	188
Pigfish, *Orthopristes chrysopterus*					157	157
Sharks	64	13			2,028	2,106
Inshore and pelagic species:						
Redfish, red drum, *Sciaenops ocellata*	1,297	596	66	260	2,053	4,272
Black drum, *Pogonias cromis*	1,213	301	19	141	986	2,660
Croaker, *Micropogon undulatus*	35	146	2	133	298	614
Spotted sea trout, *Cynoscion nebulosus*	1,680	639	102	370	4,376	7,167
White sea trout, *Cynoscion arenarius*	40	278	198	212	395	1,123
Spot, *Leiostomus xanthurus*		112	1		450	563
Sheepshead, *Archosargus probatocephalus*	34	138		104	732	1,008
Pinfish, *Lagodon rhomboides*					157	157
Mullet, *Mugil* sp	95	76	156	3,356	34,528	38,211
King whiting, *Menticirrhus* sp	120	500	191	193	1,761	2,765
Spanish mackerel, *Scomberomorus maculatus*	14	2	7	70	10,638	10,731
Menhaden, *Brevoortia* sp			57,340		121,912	179,252
Gafftopsail, sea catfish, *Bagre marinus*	59	343		8	469	879
Snook, *Centropomus* spp	1				512	513
Tripletail, *Lobotes surinamensis*		2			63	65
Sawfish, *Pristis pectinatus*		15				15
Pompano, *Trachinotus carolinus*	4	1		4	766	775
King mackerel, *Scomberomorus* sp	22				3,897	3,919
Flounders	135	221	168	217	751	1,492
Amberjack, *Seriola* sp					376	376
Mojarra, *Gerridae*					183	183
Permit, *Trachinotus goodei*					1	1
Tenpounder, Bonefish, *Elops saurus*					613	613
Hogfish, *Lachnolaimus maximus*					15	15
Harvestfish, *Peprilus* sp					17	17
Dolphin, *Coryphaena hippurus*					83	83
Crevalle, Jack, *Caranx hippos*				62	536	598
Cigarfish, Scad, *Decapterus punctatus*					55	55
Butterfish, *Poronotus triacanthus*					27	27
Cabio, *Rachycentron canadus*				1	119	120
Blue runner, *Caranx* sp				2	1,982	1,984
Bluefish, *Pomatomus saltatrix*			1	31	1,831	1,863
Barracuda, *Sphyraena* sp					46	46
Tarpon, *Tarpon atlanticus*						
Anadromous species:						
Alewives, *Pomolobus* sp					428	428
Gizzard shad, *Dorosoma cepedianum*					550	550
Hickory shad, *Pomolobus mediocris*					86	86
Shad, *Alosa sapidissima*					842	842
Striped bass, *Roccus saxatilis*						
Brackish and fresh-water species:						
Garfish, *Lepisosteus* sp		22				22
Catadromous species:						
Eels, common, *Anguilla bostoniensis*					60	60
Grand totals	5,130	3,436	58,270	6,697	207,393	281,466
Recapitulation:						
Bank species (chiefly offshore)	305	29	19	1,530	11,685	13,568
Bank and reef species (except offshore):						
Sharks	64	13			2,028	2,105
Others	12	2		3	1,626	1,643
Total	76	15		3	3,654	3,748
Inshore and pelagic species:						
Menhaden			57,340		121,912	179,252
Mullet	95	76	156	3,356	34,528	38,211
Sciaenids (drums, croakers, spot)	2,665	1,655	279	727	5,548	10,874
Spanish mackerel	14	2	7	70	10,638	10,731
Weakfishes	1,720	917	300	582	4,771	8,290
Carangids (jacks and pompanos)	4	1		68	3,340	3,413
Porgies (sheepshead and pinfish)	34	138		104	889	1,165
King mackerel	22				3,897	3,919
Bluefish			1	31	1,831	1,863
All others	195	581	168	226	3,274	4,444
Total	4,749	3,370	58,251	5,164	190,628	262,162
All other categories		22			1,966	1,988

shows that several species are taken only at very low salinities, while many species are taken both at low and at high salinities. Information is lacking as to whether the abundance of the latter group is dependent on low salinities. It may be that the nutrients carried by the rivers are of much greater importance than the salinities in determining both distribution and abundance.

The statistics on the catch are contained in the following table. Unfortunately, the Atlantic and Gulf coasts of Florida are not separable. Most of the Florida catch is from the Gulf coast and the Florida Keys. Out of a total catch of 281 million pounds, 179 million were menhaden, leaving only 102 million pounds of food fish for the five States.

Of the food fishes Florida produced 86 million pounds against only 16 million for the other four States. Considering the long coast line involved, this is a very small fishery.

Probably the chief problem now confronting fishery biologists in the Gulf is to ascertain the cause of the low productivity of the fin-fish fisheries. It may be more than mere chance that the greatest producing areas are where the two prongs of the land, the Florida and Yucatán Peninsulas, project close to the currents that flow from the Caribbean Sea into the Gulf and then turn eastward to flow out of the Straits of Florida.

The important shrimp fisheries appear to depend on nutrients from the land. The young shrimp are reared in the shallow marshes, and the older shrimp live on the mud bottoms, especially on both sides of the present Mississippi Delta and on bottom that was part of former deltas.

From the accounts of the fishery explorations and of the red snapper fisheries one gains the impression that the bottom fisheries of the Gulf are incapable of any large expansion. There remain then, unless further research proves otherwise, two sources of possible expansion. One is the tremendous potential productivity of the inner bays if the problems of fluctuating salinities can be solved. The other lies in the expanded exploitation of the pelagic fishes, especially those subsisting on the plankton, such as the menhaden, the anchovies, and other clupeids. Only exploitation will tell us whether these fishes can support a large catch.

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